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PROGRESS REPORT OF THE REGIONAL RESEARCH LABORATORIES

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Remarks of Dr. Henry G. Knight, Chief, Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, before the Land Grant College meeting, Chicago, Illinois, Tuesday, November 11, 1941.

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It is a genuine pleasure for me to be with you on this occasion and to report on the progress of the work in the Regional Research Laboratories which were authorized by Congress in 1938 to search for new and wider industrial outlets for farm products.

These Laboratories have passed from plans on the drawing board to structures of brick and steel. All main buildings have been completed and occupied, and partly staffed and equipped. There are now about 180 people employed in the Northern Laboratory; about 155 in the Southern Laboratory; 160 in the Eastern, and 155 in the Western. In other words, something like 650 of the approximately 1,000 people that will ultimately be employed in these Laboratories have already been hired and are actually at work.

Equipment has been installed or is being installed in 51 of the 72 individual laboratory units in the Northern Laboratory; in 36 of the 72 units in the Southern Laboratory; in 51 of the 96 units in the Western Laboratory; and in all of the 72 units in the Eastern Laboratory. We are having considerable difficulty in getting some of the equipment needed on account of the defense situation, but we are doing the best we can under the circumstances. I might add that we are also beginning to experience difficulty in obtaining scientists, but we can't complain because we know that scientists generally are being called in increasing numbers to help in the expansion of the country's program of National defense.

It may interest you gentlemen to learn that an increasing amount of research in these four Laboratories is centering around defense activities. Defense activities used to refer mainly to muskets, bayonets, and cannon. But it's much broader than that today. Defense activities under present conditions comprise not only those lines of research directly related to military operations, but also the secondary problems that arise in connection with the needs of the civilian population as well as the military forces. Of course, these Laboratories were designed for peace-time investigations, and so far as we know the entire staff of scientists will eventually return to that field of work, but for the present, at least, some of our ablest scientists are engaged in research which is either directly or indirectly linked up with National defense.

I don't mean to infer that these Laboratories are taking in corn-stalks and turning out smokeless powder. The problem is not quite that simple. The job of the modern agricultural research laboratory is to take farm products and show industry how some of these, at least, may be used in the production of things that are needed in the modern defense program of today. Let me give you a few examples of what scientists in these Laboratories are doing in this field---right now.

Nitrocellulose, or what we used to call gun-cotton, is the basis for modern smokeless powder, which we are manufacturing in this country just as fast as we can. The cellulose which is used in making nitrocellulose normally comes from cotton linters. Our supply of chemical grades of linters is normally sufficient to meet our own needs, but with this country acting as the "arsenal for Democracy," our supply of linters is

not sufficient to meet the combined needs of this country and the countries we are supplying.

Raw lint cotton has certain advantages as an alternative source of high-grade cellulose for use in an emergency, although, of course, it normally is too valuable for other purposes to be diverted to this use. In anticipation of a shortage of linters, our Southern Laboratory at New Orleans began last February to investigate the possibility of using lint cotton for making smokeless powder. After successful laboratory experiments, plant-scale investigations were carried out in cooperation with industry and the Navy Department. Although the final results of these investigations are not yet available, there is every indication that they will be successful. The principal problem involved in using lint cotton in smokeless powder is cutting it efficiently and quickly to suitable lengths for purification and nitration with existing equipment. A new type of cutting machine is now being designed which we hope will solve this problem.

I might say that we are attacking this problem of cellulose supplies from several angles. As you Directors know, there are large quantities of cellulose in such agricultural residues or waste materials as cornstalks, corncobs, cotton stalks, bagasse, and in the straws of oats, wheat, barley, rye, and so on. A lot of research is needed before we can say whether or not the cellulose in these now largely wasted farm residues can be obtained on a satisfactory commercial basis.

Our Northern Laboratory at Peoria, Illinois, is giving considerable thought to the whole cellulose problem, particularly as it pertains to farm residues or wastes. Our scientists are studying the cellulose problem

from a great many angles, and when they get through we hope to know a great deal more about this entire cellulose situation than we do at the present time.

Before leaving the cellulose topic I might tell you about the Bureau's work on the water chestnut which is clogging navigable streams in increasing numbers along the Eastern Seaboard and in sections of the Gulf Coast region. One day last summer President Roosevelt was cruising down the Potomac River accompanied by Secretary Wickard. The President suggested that Secretary Wickard have some of the Department scientists look into the possibility of making paper or some other industrial product from the thousands of acres of this floating menace to navigation.

The Bureau of Agricultural Chemistry and Engineering was assigned the job of making this investigation. The cellulose or paper work was turned over to the Agricultural Wastes Division in the Northern Laboratory, and the enzyme research handled by the Enzyme Research Division of the Bureau in Washington. The U. S. Army Engineers gathered and shipped quite a quantity of the water chestnut plants and nuts to the Northern Laboratory where, believe it or not, the plants were actually made into paper. But on account of the present cost of processing these plants it is not economically profitable to make paper from them under present conditions. The research is still under way and we can't say yet until the project is completed whether or not these plants have other possibilities. But when we get through we'll know. We won't have to guess. The point I want to make is that in having these Laboratories we have the organization and the equipment for rapidly and accurately finding out whether or not it is profitable to utilize the products of the soil for industrial purposes.

Returning now to the National Defense angle of the research in these Laboratories, I might say that we have been called upon to assist in the solution of a large number of "defense" problems. Some of these problems involve finding domestic substitutes or replacements for imported materials which might be wholly or partially cut off in the event of war. For instance, sandbags are a military necessity which are needed by the millions in warfare; yet, until recently, all of the sandbags were made from burlap (jute), which is imported from India. From time to time the Bureau of Agricultural Chemistry and Engineering has urged the War Department to substitute suitable domestic cotton fabrics for burlap in sandbags, because in any major emergency this country probably would be unable to secure adequate supplies of this material. It was suggested that certain cotton fabrics which have the required strength and other qualities, and which are already produced in large quantities in this country, could be specified for this purpose. Textile technologists of the Southern Laboratory have analyzed and tested a large number of commercially produced cotton fabrics, correlated these results with data obtained from actual service tests, and used their findings as a basis for drawing up minimum detailed specifications for use in purchasing cotton sandbags.

Soon after the War Department adopted specifications for sandbags made from cotton fabrics, our Bureau was requested to conduct research to determine the most effective treatment for preserving fabrics against attacks by micro-organisms. In compliance with this request, our chemists and bacteriologists made exhaustive tests of practically all known preservatives and made these results available to the War Department.

Another of our attempts to increase the Nation's self-sufficiency in the event of war involves fire hose. The hose used by fire departments consists of circular woven cotton fabric lined with rubber, which is a strategic material. Then there is the unlined fire hose, kept for emergency use in industrial plants and other buildings that is made of linen, an imported commodity. At the request of the Civilian Defense Administrator, our Southern Laboratory is attempting to develop fire hose made entirely of domestic materials, that will be sufficiently strong and leakproof for both types of use. We believe we can achieve this object by developing a more closely woven cotton jacket than is now available, and by coating the inside of this jacket with a water resistant, pliable resin. Results obtained thus far are promising, but it is, of course, too early to predict the successful outcome of these efforts. I might mention that this project is being co ducted in cooperation with a prominent cotton manufacturer.

A number of other problems involving strategic and critical materials are receiving attention in the Bureau of Agricultural Chemistry and Engineering. In fact, our national requirements for most of these materials have been closely studied and a research program aimed at replacing them with products of American agriculture is now under way. For example, the ropes used by the Navy and for a wide variety of industrial purposes are made of manila hemp, which is imported from the Far East. Much of the binder twine used to harvest our wheat and other small grains is made from fibers imported from Mexico, the Dutch East Indies, and Africa. As you know, steps have already been taken to build up "stock piles" of these strategic and critical materials, but we cannot afford

to sit idly by and wait until these supplies are exhausted. So we have started research on a number of these problems in an effort to develop domestic substitutes for these imported products which are essential to the National defense.

In our effort to send food to our friends across the ocean we have suddenly come face to face with the fact that shipping space is not as plentiful as it used to be. To help meet this situation we are pushing a Bureau-wide research project in the Western Laboratory at Albany, California, on the dehydration of vegetables. Scientists have been drawn from all over the Bureau to help in this important and much needed research and I'm glad to report that the work is now well under way. The dehydration of fruits and vegetables not only saves valuable shipping space, but it saves on weight since the weighty water is taken out of these products in the dehydration.

One of the main troubles with dehydrated products during the first World War was the off-flavor of the product after it was restored to its natural condition. We are working to correct this difficulty as well as to make improvements in color, and other things that add to the attractiveness, palatability, nutriment, and keeping quality of dehydrated products. The crops being studied under the present set-up include white potatoes, carrots, onions, sweetpotatoes, cabbage, and other leafy vegetables.

Another timely piece of research that is under way in the Western Laboratory is the work on frozen foods. During the summer Secretary Wickard announced a program to increase the production of a great many farm crops and commodities. This program met with rather general approval, and there has already been a considerable increase in the production of

milk, and eggs, and some other commodities. The question that naturally arises in connection with this increased production is, how is the best way to store and keep these products until they are consumed?

The ever-normal granary seems to be serving a good purpose in that field. The dehydration project and the frozen pack project in the Western Laboratory will contribute to this general objective. The frozen pack work that was formerly done at Seattle and at Los Angeles has been centralized at the Western Laboratory where adequate facilities are available for an expanded program in this field. Research in the frozen pack work is being pushed as fast as possible in the hope that new information will increase its usefulness as an agency to help care for the increased production called for under the Secretary's program.

In time of war there is a great increase in the demand for certain types of leather. It is needed to make shoes for marching soldiers, and for other war-time purposes. We now import about half of the material that is needed in tanning the leather that is produced in this country.

Due to the shortage of ships and the discrimination against cheap cargoes like tanning material the situation in this field is steadily growing worse. Prices of certain tanning materials are still rising as supplies dwindle and new shipments become increasingly scarce. In general the prices of tanning materials have risen from 15 to 25 percent since the outbreak of the war. In an effort to meet this situation the Bureau of Agricultural Chemistry and Engineering, through its Eastern Laboratory at Philadelphia, is making a very thorough study of plants and trees in this country that give promise of producing satisfactory tanning materials in commercial quantities. This tanning material investigation was started

in the Bureau of Chemistry and Soils several years ago and has been transferred to the Eastern Laboratory where it can be expanded and pushed more rapidly.

We have found what we believe to be a very good source of commercial tanning material in the bark of the Western hemlock tree. The results of laboratory-scale investigations with Western hemlock bark have been very satisfactory. What we really need now is a pilot plant at some point in the Pacific Northwest where this bark is produced in large quantities.

The canaigre plant which grows wild in a number of areas throughout the Southwest is a promising plant for the production of tanning material. Our scientists in cooperation with scientists of the Bureau of Plant Industry and the Soil Conservation Service are making thorough studies of this and other plants of a promising nature in the hope of finding an outlet to this gradually tightening bottleneck in the leather industry.

The Eastern Laboratory is in the midst of another investigation which may prove to be of considerable economic importance as well as a help in providing our people with a better balanced diet. This new project centers around the attempt to produce nicotinic acid on an economically commercial basis from nicotine. Nicotinic acid is the pellagra-preventing member of the vitamin B complex and is called by some the P. P. or pellagra-preventing vitamin.

This new project is centering mainly around an attempt to produce the nicotinic acid from the nicotine of an old and practically discarded type of tobacco known as Nicotiana rustica. This species of tobacco is capable of producing two or three times more nicotine per acre than the ordinary varieties, and we are hopeful that this thing can be worked

out so that it will become economically profitable for the small tobacco farmer to produce a nicotine crop as a supplement, replacement, or cash crop. Tobacco growers in Western Kentucky and Tennessee whose land is suited for only the heavier types of tobacco have been searching for substitute cash crops since they no longer have an outlet for about 76 percent of their production which was formerly exported. Because of this situation 100 Tennessee farmers grew experimental acres of Nicotiana rustica tobacco this year in cooperation with scientists of the Bureau of Plant Industry.

There are now two substantial outlets for nicotine, one in the food reinforcement field after the nicotine has been converted into nicotinic acid, and the other as an insecticide. You are all acquainted with the importance of nicotine in the insecticide field and with the splendid accomplishments in recent years of making it function as a stomach poison as well as a contact poison. And of course you know how the demand for nicotinic acid has increased since last January when the Committee on Food Nutrition recommended enriching white flour with thiamine, nicotinic acid, iron, and riboflavin when it becomes available in sufficient quantities. It is estimated that 200,000 pounds of nicotinic acid will be required this year for flour enrichment, and another 20,000 pounds for use in pellagra treatment. This demand is about 20 times larger than the total amount of nicotinic acid produced in 1940, and would require around 20 million pounds of tobacco were all the acid made from tobacco nicotine.

At present coal tar competes with nicotine from tobacco as a source of nicotinic acid. And it's entirely possible that tobacco

cannot compete with it, but we are going to make a very thorough search in this field before we make any commitment. All we can say now is that the project looks promising.

The British fondness for cheese has tossed another problem into the lap of our Bureau. As you know, the coatings on most slick book and magazine paper contain casein, one of the milk proteins. It is the same protein which makes up the greater part of cheese. So when we increased our exports of cheese to Britain to shiploads instead of the smaller shipments we had been accustomed to making, it decreased our supplies of casein for other purposes and this in turn struck the American paper mamufacturers a heavy blow.

Naturally, we are trying to do what we can to remedy this situation. At the Department's Soybean Laboratory down at the University of Illinois, we have been working for sometime to extract a protein from soybean curd which could be used as a substitute for casein. They have succeeded, and a commercial plant is already in operation and expects to turn out about 6 million pounds of this new soybean-protein this year. Another plant is under construction. But there is still a shortage because it is estimated that we need about 20 million pounds of this protein this year. We have enough soybean meal to produce the protein, but we don't have the processing machinery to get it out, and that's why the shortage of this substitute for casein is pinching.

This problem will undoubtedly be solved in time. Two of our Regional Laboratories have stepped into the picture of producing industrial proteins and are attacking the problem from two different angles—the Western Laboratory with regard to alfalfa proteins and the Northern Laboratory

from the standpoint of zein which is a product of corn. Investigations show that zein can be used in certain types of paper coatings as well as for other purposes. A small amount of zein is now obtained in the manufacture of cornstarch. Much larger quantities could be produced if the price justified it. Then there is the possibility of finding a cheaper way of getting zein out of the corn. Alfalfa proteins have not been produced for industrial purposes but they offer a large potential source of supply which may prove to be satisfactory for some uses. Our scientists are working hard on these problems, but what the results will be is too early yet to say.

Glycerine is an important ingredient in high explosives. It is obtained at present, largely through the breakdown of animal fats. You may recall that it was the lack of fats that contributed to the collapse of Germany during the World War. Many of our crops such as corn and potatoes are composed largely of starch. We not only produce large quantities of starchy crops in this country but we could expand the production of these crops rather rapidly.

It's possible in the laboratory to make glucose from starch, and from glucose to make glycerol which is just another name for glycerine. And the fact that a good chemist can produce glycerine from glucose in the laboratory flask offers a ray of hope, because the time may come when we will need to utilize every possible source of raw material in the production of high explosives.

And this, by the way, is a good time for me to bring into the discussion the part that the pilot plant is playing in the Regional Laboratory program. Sometimes it's a fairly easy matter for a good

chemist to produce something in the laboratory on a very small scale. The rub comes when the manufacturer sets up a commercial plant and attempts to turn out large quantities of this product based on nothing more than test tube results. The pilot plant is needed to bridge the gap between the test tube and the commercial plant. In reality a pilot plant is a small-sized commercial plant designed so that records and cost accounts can be kept on production. These, in turn, help the prospective manufacturer to reach a constructive conclusion as to whether or not it would be profitable for him to enter that field.

As I said a moment ago, a good chemist can produce glycerine from glucose on a small test-tube scale. But to get this production out of the laboratory flask and into full-scale factory production on a profitable basis is a far more difficult problem, and one that would involve pilot plant research. But pilot plant research is one of the functions of these Regional Laboratories, and our chemists and engineers are pushing this part of the investigation just as they are stressing the test tube part of the research. Both are needed in a well-rounded research program.

Each of the four Laboratories, as most of you know, has a large space designed and set aside for pilot plant research, and pilot plants are now under construction at all of the Laboratories.

The erection and installation of a pilot plant for the production of motor fuel from agricultural products is well under way at the Northern Laboratory. This pilot plant would have been completed months ago if we could have gotten the construction materials and the equipment. We haven't obtained all of the necessary equipment yet, but we hope to have enough in a short time to enable us to get started.

The pilot plant at the Peoria Laboratory is large enough to produce 500 gallons of fuel spirits a day. We are installing the most modern equipment that we can get under the existing emergency conditions. We are developing the most efficient strains of yeast to be used in fermenting the raw material. Our first work is with corn, but we expect to work on a great many farm products and byproducts in our attempt to get accurate and constructive facts on this motor fuel problem.

I have repeatedly stated that the pilot plant scale facilities of the Regional Laboratories would be made available to workers in Agricultural Experiment Stations who have developed in the laboratory new products or processes which have commercial possibilities, but on which for lack of pilot plant facilities, development to that intermediate stage necessary for successful commercial exploitation is impossible. The first typical cooperative project of this kind is now being carried on between the Delaware Agricultural Experiment Station and the Eastern Regional Research Laboratory at Philadelphia. At the Delaware Experiment Station one of the workers had developed in the laboratory a method for the production of a new type of pectin from apples having special properties which would appear to have extensive use in the food industry. In our apple utilization studies at the Eastern Laboratory we are of course interested in the development of new outlets for apples and products derived from apples. A natural tie-up seems to have existed, and arrangements have been worked out and are being carried forward successfully between the two organizations. I feel certain that many similar cooperative projects will be undertaken in the future with mutual advantages to the Stations and to the Laboratories.

I haven't attempted to discuss all the projects that are under way in these four Regional Research Laboratories. It would be impossible to do that in one short period. I have merely mentioned a few to let you know that the Laboratories are actually at work on the program that has been outlined for them. I mentioned some but not all of the projects with a defense angle to show that the Laboratories are really potential agencies to help make the country safe for democracy.

Vice President Wallace said when he laid the cornerstone of the first of these Laboratories at Peoria, Illinois, on October 18, 1939, "It is a comforting thought to know that this great research Laboratory that we are laying the cornerstone for today, and the other three that are under construction in other parts of the country, could be turned into research institutions for National defense should the occasion demand." I hope of course that the time never comes when it will become necessary for us to direct all of the energies of these Laboratories toward the defense of our country. I had much rather see these great research units continue their search for ways to help farmers make more money and thereby improve their standard of living. But, as the Vice President said, it is a comforting thought to know that they can serve in the other capacity to the fullest extent should that become necessary.

When you cut your finger, you don't just stand and look at it. You usually put something on it if you can get it. That's characteristic of the American way of doing things. It seems to me that we fretted longer than usual about the farm surpluses before we started to do something about the matter. But I'm sure you'll agree with me when I say that the old rugged agricultural system of this country has undergone some great

changes in the last 6 or 8 years. Soil Conservation, the Triple A, Farm Credit, Surplus Marketing, Crop Insurance, and many other new agencies are now playing important parts in the farm program of today.

The Regional Research Laboratories are among the things that came into being as a result of the surplus situation. And with the splendid help and cooperation we are receiving from the State Agricultural Experiment Stations of the country we have started in to carry out the program that these Laboratories were designed to follow.

Nearly all of you Directors have seen these Laboratories. But it has been sometime since some of you saw them. We not only want you to see them again but we want you to see them as often as you can in order that you may know what is going on. And now that we are in operation in all four of the Laboratories it seems to me that it would be wise for us to complete the job of appointing the Agricultural and Industrial Relations Committee. This, as you know, is what we call the "Visiting" Committee.

I'm planning to start the machinery for the appointment of these committees, one for each of the Laboratory regions, as soon as I get back to Washington. Invitations to become members of the Visiting Committee will be issued before the first of the year in the hope that the job may be completed and the committees organized and ready to function by next spring.

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